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Environmental friendly solar energy in Pakistan's scenario

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ABSTRACT

Like many other developing countries of the world, Pakistan is also energy deficient country. Since last few decades, its electricity generation has become dependent to a large extent on the petroleum fuels. The inevitable depletion of petroleum resources will have far reaching consequences on large scale development for future, unless renewable energy alternation can be found.

Contents

1. Introduction

Environmental quality is not easy to quantify, but several indicators may be used to show the trend. One of these indicators is undesirable gasses emission due to combustion of non-renewable (fossil fuels) energy sources. In 1950, worldwide fossil fuel combustion emitted 1.6 billion tones of carbon. By 1979, carbon emission has fallen off somewhat, perhaps due to reduced oil consumption and improved emission control [1]. It is well known fact that future environmental quality will be influenced significantly not only by level of world energy consumption but also the means of consumption [2]. On the other hand, rapid increase in agricultural production is only possible with higher use of energy [3].

Energies can be classified into renewable and non-renewable forms. Renewable energy sources are considered, as environmental friendly while non-renewable energy sources are not only exhaustible in their nature but are also creating pollution and therefore are harmful for environment.

Solar energy is also one of the non-renewable inexhaustible source of energy that is potentially capable of meeting a significant portion of the global energy need with a minimum of adverse environmental consequences. The solar energy presented to earth is almost 700×10^{12} MWh each year. The average intensity measured on a plane perpendicular to its path at 160 km above the earth's surface, is about 1.35 kW/m^2 [4]. The maximum solar energy received on earth surface is from 6 to 8 kWh/m^2/day, i.e., 1.5–2 MWh/m^2/year. However, it is encountered only near the equator on clear day at noon [2]. On clear days the radiation might be 90% direct, and on cloudy days it could be 100% diffuse. The solar radiation striking a surface will always be composed of these two components. It was estimated that in 2005 total consumption of energy was only 0.14×10^{12} MWh [5].

Fortunately, Pakistan is in a blessed location for this unending source of energy that can be converted to useful form by appropriate technologies of direct energy conversion. However, the energy sector in Pakistan is expressed by

1. High dependence on biomass energy. This belief was due to the fact that almost 67% population, living in rural areas of Pakistan, uses traditional fuel like firewood, dung and crop residue to fulfill everyday energy requirement. As a result it was estimated

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that consumption of biomass energy was almost 27% of Pakistan total energy consumption [6].
2. An overexploitation of the forest resources. Forest covered only 5.2% of the total area of the country in 2006–07 [7]. Unfortunately, this resource is decreasing with every passing by day due to lack of awareness.
3. Heavy dependence on imported petroleum products [8].
4. Under exploitation of renewable sources like solar, wind [7].

It is believed that for installing Solar Photovoltaic (SPV) appliances like water pumps, the average daily solar radiation in the least sunny month should be greater than 3.5 kW/m^2 on a horizontal surface [9]. On average, the country receives 7.6 h of sunshine per day with average solar radiation of 5–7 kWh/m^2/day over more than 95% of its area with persistence factor of over 85% [10]. Therefore, the conditions to harness solar energy are not only excellent but also sustainable. Although in addition to other partly working departments, two fully fledged departments (Pakistan Council of Renewable Technologies, PCRET, and Alternative Energy Development Board, AEDP) are dedicated to the acceleration of renewable energy technologies (RET) development, yet, the reported cumulative numbers of dissemination of most of the RETs are very low, particularly harnessing solar energy for agricultural applications [7]. Main constraints to widespread utilization of solar PV technologies are

- high initial cost of PV system
- inadequate renewable energy policy (in fact the government has not properly realized the need of RET)
- unawareness in local communities
- inadequate availability of technical know how.

2. Power scenario in Pakistan

Pakistan's primary energy supplies for the year 2007–08 amount to 62.92 million tonnes of oil equivalent (TOE). Pakistan's energy demand far exceeds its indigenous supplies. Oil and gas form the bulk of primary commercial energy supply mix of Pakistan, contributing 78.7% (oil: 30.5%, gas: 47.5%, LPG: 0.7%). The other sources include; coal: 9.2%, hydro electricity: 10.9%, nuclear electricity: 1.2% and imported electricity 0.1% [8]. Consumption of fossil fuels such as oil and natural gas has reached a turning point from the standpoint of confirmed energy reserves of Pakistan. On one hand, with a population of 160.9 million in 2008, that is expected to reach 171 million by the year 2010 (Fig. 1), the demand for fuel is expected to continue to grow [11]. Due to this increase it is strongly expected a high increase in the amount of energy consumed in the future. As explaining the world situation, Kuwano [12] stated that as the population of world increases energy consumption will also increase. Hence in the coming years, a gap between energy required and production volume of fossil fuels (called 'energy gap') is strongly expected to grow.

On the other hand, crude oil reserves that were originally 125.55 million TOE, besides cumulative production of 81.73 million TOE, remained 43.83 million TOE in mid 2007. Therefore, to fulfill the requirement of the country government of Pakistan got to import the crude oil of worth 5740.86 million US$ in 2007–08, whereas this import was 538 million US$ in 1995–96 [8]. Similarly in case of natural gas, the original reserves were 1052.77 million tones of oil equivalent, besides having cumulative production of 501.55 million TOE, the balance of recoverable reserves remained 551.22 million tones of oil equivalent in 2007–08.

Although Government of Pakistan is in its utmost try to electrify the country but still the actual number of electrified household is very low. Moreover, rural electrification has extended the conventional grid in the region and there has been no provision of decentralized power generation and distribution. This has resulted in poor quality of power with high voltage fluctuation and long power cuts.

One of the major reasons for low level of electrification is the remoteness of the region and the difficult terrain. It is extremely difficult if not impossible, to extend high-tension transmission lines to all the remote areas of Pakistan, especially in Balochistan and N.W.F.P. as the villages are sparsely located. Moreover the transmission and distribution losses and especially in the hilly areas of the country are also very high. Since it is also highly cost prohibitive to draw transmission lines to such locations, SPV technology is considered to be a feasible option for providing clean energy to these remote settlements.

3. Energy strategy of the government of Pakistan

Several studies have been conducted by the government and international institutions (like World Bank and Asian Development Bank, etc.) in order to enhance national energy programme. Due to acute shortage of electricity and having the burden imposed by imported petroleum products, priority was given to the development of mega structures for hydropower. Some of the under construction mega structure in the country are Allai Khwar, Khan Khwar, Duber Khwar, Jinnah and Neelum Jhelum hydropower projects. The dams under construction are Gomal Zam Dam, Mirani Dam, Sabakzai Dam and Satpara Dam. The future projects announced by the top authorities of Pakistan include Diamer Basha Dam, Kurram Tangi Dam, Munda Dam and Akhori Dam projects. The hydropower projects about which feasibility study is being conducted includes Golen Gol, Dasu, Bunji, Keyal Khwar, Lawi, Pallas Valley (Chor Nullah), Spat Gah, Basho, Phandar, Jabban, Thakot and Patan hydropower projects [13]. Kalabagh Dam, is also

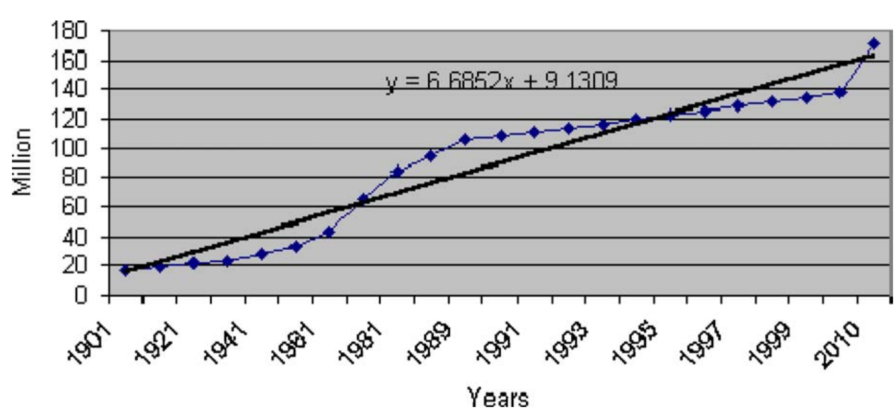


Fig. 1. Prospect of population of the country.

one of the major under consideration dam, however, besides having complete feasibility report up-till now its construction could not be started due to political reasons.

In National Renewable Energy Policy (NREP), announced in 2002, besides other policy matters, the following targets were set by the committee working on it.

1. Renewable energy resources will acquire 3% share in primary commercial energy supply by 2010.
2. Every year 2% of the annual development budget will be allocated for the development of renewable technologies in the country.
3. All localities anticipated to be connected with national grid in next 30 years are to be reserved for renewable energy sources.

Solar power system is often considered too expensive when compared to conventional power system. This is because the cost of a single unit photovoltaic is compared with the power available at the doorstep of the house. This comparison does not depict the true picture of cost analysis. In the national policy, the (fixed and running) cost of some mega projects is compared with the solar project. For example, it was observed that Ghazi Barotha Dam (another under construction mega structure for hydro power) cost Rs. 118 million per MW (US% 2.2 billion for 1400 MW), whereas solar thermal power system will cost Rs. 70 million per MW. This is direct saving in construction, whereas, operation cost of both the systems will be almost same.

3.1. Factors affecting the utilization potential

The potential of Solar Energy Technology (SET) depends on several factors such as availability of resources and technology in the area, affordability of common man, and their inclination to invest in a SET, etc.

3.2. Availability and affordability for the use of solar energy

A single crystal silicon cell is the basis for solar's technology. A module efficiency of 11% was achieved in 1986 at the cost of US \$ 550/m^2, which resulted in an electrical energy cost US \$ 0.75/kWh (US \$ 0.75 = Rs. 15/kWh as US \$ 1 was = Rs. 20 at that time). Module efficiencies of 15% and cost of US \$ 100/m^2 may produce electricity at US \$ 0.06/kWh (US \$ 0.06 = Rs. 5.1/kWh as US\$ 1 = Rs. 85) a price that is cost comparative with many other energy supply options [2]. PCRET have achieved 13% efficiencies on 4 in. round plainer solar cell with single layer antireflection coating [14].

3.3. Inclination to invest in a SET

Due to increasing consumption and consequently uncertainty in the availability of electricity, the renewable energy and especially solar energy based appliances are extremely important to be developed. However, for the inclination of a common man to accept this energy, not only government but also other institutions including NGO's will have to play an important roll in awareness among the people.

4. Conclusion

The nature of the climate, the amount of solar energy available, dwindling situation of commercial energy sources and energy demand across the country make Pakistan a high potential country for widespread promotion and utilization of environmental friendly renewable energies and especially PV technology. It is imperative for the development to promote the achievements by taking serious financial and administrative steps for allocation of proper resources for its dissemination. Research work in this field of PV technology need top priority in the country. The efforts to alleviate poverty cannot be fruitful without sustainable energy system throughout the country. It is very difficult, if not impossible, the future development without propagation of solar energy, in the environment of most of the developing countries including Pakistan.

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